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THE ROLE OF FORENSIC ENTOMOLOGY IN CRIMINAL INVESTIGATION: ITS DEVELOPMENT AND APPLICATION IN MALAYSIAN ADMINISTRATION OF CRIMINAL JUSTICE

Oleh

RAJA MUHAMMAD ZUHA BIN RAJA KAMAL BASHAH

Projek Penyelidikan bagi memenuhi sebahagian daripada syarat-syarat untuk
Ijazah Sarjana Pengadilan Jenayah

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ABSTRACT

Forensic entomology in criminal investigation has been considered as one of the most important aspect in criminal justice. As it stands as corroborative evidence in court, the importance of scientific method in forensic entomology reveal the structure of conviction towards the guilty party by estimating time of death, finding cause of death and determine the location of a body. This paper discussed the importance of forensic entomological data in criminal investigation. It is revealed that such evidence just not only helps to establish post-mortem interval (PMI) but the role of the scientific nature of such evidence could provide facts to corroborate conviction or even overturn a conviction. It is also important to homogenize the methods of entomological evidence recovery in the field and in the laboratory as any defect could affect the expert testimony in court. The malpractice of evidence recovery could become the weaken factor for the evidence to be admissible in court. Several problematic factors identified from insect evidence recovery at the crime scene in Malaysia. However, ideas, how to strengthen the value of forensic entomological data is displayed through standard guidelines and procedures.

ABSTRAK

Entomologi forensik dalam penyiasatan jenayah dikenal pasti sebagai salah satu aspek terpenting dalam bidang kehakiman jenayah. Sebagai bukti pengukuh di mahkamah, kepentingan kaedah saintifik entomologi forensik adalah untuk mendirikan struktur pertuduhan ke atas pesalah dengan menganggar waktu kematian, mencari punca kematian dan menentukan lokasi mayat. Projek penyelidikan ini membincangkan kepentingan data entomologi forensik dalam siasatan jenayah. Ia telah dibuktikan bahawa bukti sedemikian bukan sekadar mewujudkan jangka waktu kematian (PMI) tetapi kepentingan bukti semula jadinya memberikan fakta untuk memperkukuh tuduhan atau menterbalikkan tuduhan ke atas suspek. Oleh itu, adalah penting untuk menyeragamkan kaedah perolehan bukti entomologi dari lapangan dan di dalam makmal kerana sebarang kesilapan boleh mempengaruhi keterangan pakar di mahkamah. Kegagalan pengamalan kaedah yang betul ketika mendapatkan bukti entomologi forensik boleh menjadi faktor pelemah kepada penerimaan bukti tersebut di mahkamah. Beberapa aspek permasalahan mengenai perolehan bukti serangga di Malaysia telah dikenal pasti. Bagaimanapun penggunaan kaedah dan cara kerja standard dijangka dapat mengukuhkan data entomologi forensik.

APPRECIATION

In the name of Allah s.w.t., the Most Gracious and Most Merciful. Alhamdulillah , this research project is successfully completed. Thanks foremost to my supervisor, Puan Edah Mohd. Aris, for her kindness and guidance to help me with this study.

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I am honored to learn about forensic entomologists who inspired me to live in the world of forensic entomology – Megnin, Smith, Catts, Goff, Bornemissza, Erzingclioglu, Baharudin Omar, Lee Han Lim and Edah Aris. God bless you all.

Thank you.

CASE LIST

1. Junaidi Bin Abdullah v. Public Prosecutor, [1993] 4 CLJ 209.
2. Public Prosecutor v. Muhamed bin Sulaiman, [1982] 2 MLJ 323.
3. Munusamy v. Public Prosecutor, [1987] 1 MLJ 492.
4. Dato' Mokhtar bin Hashim v. Public Prosecutor, [1983] 2 MLJ 270.
5. Hi Chiang v. Public Prosecutor[1994] 2 CLJ 151
6. Torenia's case, 2 Lloyd's Rep. 210.
7. Daubert's case, 509 U.S. 582-583.
8. United States v. Bynum, 3 F.3d 769 (4th Cir. 1993).
9. Lau Zhan Chen (an infant by his mother and next friend Lau Fatt Wan (f)) v. Makoto Togase & 2 Ors, [1995] 1 AMR 281.
10. Frye v. United States, [1923] 293 F. 1013
11. People v. Kelly, [1976] 549 p.2d 1240
12. United States v. Scheffer, [1998] 523 U.S. 303 (1998)

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1. INTRODUCTION

The role of forensic science in criminal investigation has been considered as the most important aspect in legal process. As it stands as corroborative evidence in court, the importance of scientific method in forensic studies reveal the basic structure of conviction towards the guilty party.

The "forensic" terms derived from Latin word 'forensis' which means a forum for public. Then term of 'forensic science' itself can be defined as the application of fundamental thinking to be applied in a legal debate, i.e. in the criminal court.[1]

Forensic science generally can be divided into various fields. Ballistics studies bullet and firearms involves at a crime scene while forensic toxicology analyzes chemical causation in crimes. There are other forensic areas dealing with human bones to identify persons and cause of death called forensic anthropology and forensic dentistry helps investigators to positively identify a person.

However, these fields of forensic science can be simplified in a simple structure of two different groups (Figure 1.1).

First is the evidence of a human. This involves all of the direct evidence linked from a dead body and can be found on the body as clues to investigate murder. For example, forensic pathology can determine the cause of death based on the type of injury inflicted on the body. Forensic dentistry meanwhile is another example that can help to deliver the confirmation of an identity of a person.

Second is the evidence of an environment which includes the direct link of an object that can be crucial to be connected with the dead body. For instance, DNA and

[1] Complete wordfinder. Reader's digest Oxford. Reader's Digest.

fingerprint found on a weapon could link the suspect with the particular crime. Another example, insects or faunal succession on dead body can provide information on time of death. Traces of poison found in mouth cavity or blood can determine toxicology compound involves in the foul play or the person committed suicide.

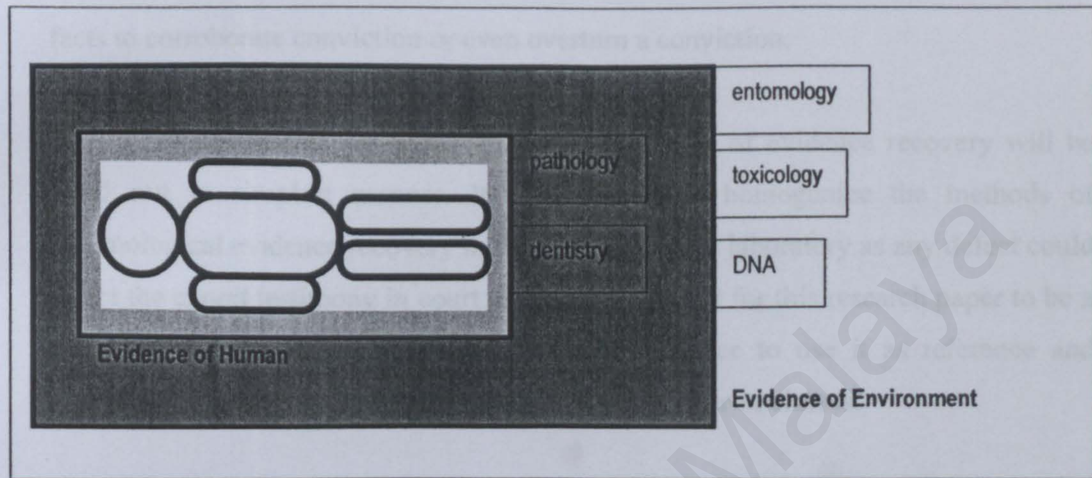

Figure 1.1 Forensic evidence structure

As for this research project, forensic entomology will be highlighted as one of the scientific evidence application in court. It is basically known that this field requires expert opinion, mainly to estimate the time of death of a dead victim. It is also known that forensic entomology provides post-mortem interval (PMI) estimation based on the ecology of insects found on the cadaver and the environment related to the cadaver.

Generally, forensic entomology means the application of data collected from insects or arthropods found on carcasses or cadaver. However, more details regarding the definition and historical value of such knowledge of forensic science will be discussed further in this research paper.

1.1 Objectives

The importance of forensic entomological data in criminal investigation will be discussed in this paper. It will be revealed that such evidence just not only helps to establish the PMI but the role of the scientific nature of such evidence could provide facts to corroborate conviction or even overturn a conviction.

Besides, the standard application or standards of evidence recovery will be ruled out in simplest manner. It is important to homogenize the methods of entomological evidence recovery in the field and in the laboratory as any defect could affect the expert testimony in court. It is also important for this research paper to be a guide for individuals who involve in forensic science to use it as reference and guidelines whether on the field, in laboratory practice or in classes.

As the conclusion for this discussion, we will later discover suggestive ideas on how to strengthen the value of forensic entomological data. The suggestions are based on observation and analysis through literatures and interviews with experts in forensic entomology studies and criminal enforcement unit.

1.2 Research Methodology

This research involves primary and secondary resources.

Primary resources consist of interviews with relevant authorities which includes forensic scientist and forensic entomologist. The information sought for this research was focused on the development and practice of forensic entomological evidence recovery.

Secondary resources include literature reviews through articles, journals and law cases regarding the importance of scientific evidence in court.

2. FORENSIC ENTOMOLOGY

Forensic entomology can be defined as application of information gathered from insects or other arthropods in criminal investigations.[2]

The roles of forensic entomology in criminal investigations are generally to determine the time of death of a body, determine the location of a body and provide clues to the cause of death. But before furthering our discussion on insect evidence found on cadaver, it is wise for us to understand the natural process that occurs after death. The essential point is that, we ought to understand how certain process of decomposition could lead to series of faunal or insect ecology on cadaver called 'succession'.

2.1 What happens after death?

After a series of pathological changes occurs on dead body such as rigor mortis[3] and livor mortis[4], the environment will determine the type of decomposition and the rate that the body undergoes.[5] For example, bodies that are left in the hot sun will not look the same as bodies that are buried and the body submerged in the water will not be similar to the body placed in a house.

Decomposition process begins after rigor passes and green discoloration will become obvious from the abdomen and spreads to the rest of the body. However, some areas of the body do not turn green because of the body's position

[2] Keh, B. (1985). Scope and applications of forensic entomology. Annals Review of Entomology, 30, 137-154.
[3] rigor mortis: The process of muscle rigidity and joints immobilize within 1-3 hours after death due to chemical process.
[4] livor motis: the discoloration of the body after death due to the gravitational settling of blood which is no longer pumped through the body by the heart.
[5] Dix, J. & Graham, M. (2000). Time of death, decomposition and identification: An atlas. CRC Press, 10.

or clothing. This process occurs approximately between 24 to 36 hours after death.[6]

After discoloration process, the body will become swollen and bloated due to the gas produced by bacteria which are normally inhabits the large intestine. This is called the bloating stage. As the body swell, the blood will hemolyze within the blood vessels and the outer layer of the skin begins to slip off the body.[7]

During bloating stage, several conditions happens on the body such as 'marbling' effect, showing visible reticulated pattern of blood vessels that closed to the skin surface. It is caused by hydrogen sulfide produced by bacteria that react with degenerated blood resulting black staining of the blood vessel.[8] At the same time, bloody fluid will come out from body's orifices especially from the nose and mouth as the result of gas pressure.

The process continues until the body's tissue becoming softens during decomposition process and degenerate into a mass of liquefied tissue. Following this process, the surface tissue will dry, collapse, darken and becoming 'leathery' before progress to skeletonization process.[9]

These series of decomposition process is one of the important elements of faunal succession on cadaver to evaluate the time of death. In forensic entomology, however, there are five basic stages of decomposition to help classifying the succession of insects on cadaver (Table 2.1).[10]

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[6] See Dix, J. 2000. p. 10.
[7] *Ibid.* p. 10.
[8] *Ibid.* p. 11.
[9] *Ibid.* p. 11.
[10] www.uio.no/~mostarke/forens_ent/**forensic_entomology**.html

The stages of decomposition process, however, vary according to time and exposure to environment. Several researches were carried previously on the field to observe stages of decomposition that could help to collectively classify insects' ecology on cadaver.

Stage	Description
Initial decay	The cadaver appears fresh externally but is decomposing internally due to the activities of bacteria, protozoa and nematodes present in the body before death.
Putrefaction	The cadaver is swollen by gas produces internally, accompanied by odor of decaying flesh.
Black putrefaction	Flesh of creamy consistence with exposed parts black. Body collapses as gases escapes. Odor of decay very strong.
Butyric fermentation	Cadaver drying out. Some flesh remains at first, and cheesy odor develops. Ventral surface mouldy from fermentation.
Dry decay	Cadaver almost dry, slow rate of decay.

Table 2.1 Five stages of decay commonly applied in forensic entomology

2.2 Historical background of forensic entomology

Based on decomposition process as discussed earlier, waves of insects' ecology could be observed occurring on carcasses or dead bodies. The wave of insects' ecology on dead bodies and carcasses is known as 'succession'.

The information on forensic entomology actually evolves through series of scientific research and observations throughout decades of history.

The most exclusive information on faunal succession can be observed through the work of Mègnin in 1894.[11] The entomological data tabulated by Mègnin recognizes eight 'invasion' waves of insects and other arthropods on human cadaver.[12]

The data obtained by Mègnin was later updated by Johnston and Villeneuve in 1897[13] (See Table 2.2).

In spite of previously, in the 17th Century, it was believed that the presence of the so called 'worms' (maggots) in cadaver was due to spontaneous generation but however, later in 1668, Franscesco Redi proved by series of experiments that these larvae came from the eggs of flies deposited on the putrefying carcasses.[14]

[11] Smith, K.G.V. (1986). A manual of forensic entomology. New York: Cornell University Press, Ithaca., 15.

[12] Between 1883 and 1898, J.P. Megnin in France published a series of articles dealing with medicocriminal entomology. The most famous of these, La Faune des Cadares, served in large part to make the medical and legal professions aware that entomological data could prove useful in forensic investigations.

[13] See Smith. (1986). p. 16.
[14] *Ibid.* p. 11.

	State of the corpse	Approximate age of corpse	Fauna
1st Wave	Fresh	First 3 months	Calliphora vicina (Dipt., Calliphoridae) C. vomitoria (Diptera: Calliphoridae) Lucilia spp. (Diptera:Calliphoridae) Musca domestica (Diptera:Muscidae) M. autumnalis (Diptera:Muscidae) Muscina stabulans (Diptera:Muscidae)
2nd wave	Odor developed		Sarcophaga spp. (Diptera:Sarcophagidae) – may occur in 1st wave Cynomya spp. (Diptera:Calliphoridae)
3rd wave	Fats rancid		Dermestes sp. (Coleoptera:Dermestidae) Aglossa (Lepidoptera:Pyralidae)
4th wave	After butyric fermentation protein of 'caseic' fermentation	3-6 months	Piophila casei (Diptera:Phiophilidae) Madiza glabra (Diptera:Piophilidae) Fannia (Diptera:Fanniidae) Drosophilidae (Diptera) Sepsidae (Diptera) Sphaeroceridae (Diptera) Eristalis (Diptera:Syrphidae) Teichomyza fusca (Diptera:Ephyridae) Corynetes, Necrobia (Coleoptera:Cleridae)
5th wave	Ammoniacal fermentation Evaporation of sanious fluids. Remaining body fluids now absorbed	4-8 months	Ophyra (Diptera:Muscidae) Phoridae (Diptera) Thyreophoridae (Diptera) Nicrophorus (Coleoptera:Silphidae) Silpha (Coleoptera:Silphidae) Hister (Coleoptera:Histeridae) Saprinus (Coleoptera: Histeridae)
6th wave		6-12 months	Acari
7th wave	Completely dry	1-3 years	Attagenus pelio (Coleoptera:Dermestidae) Anthresnus museorum (Coleoptera:Dermestidae) Dermestes maculatus (Coleoptera:Dermestidae) Tineola biselliella (Lepidoptera:Tineidae) T. pellionella (Lepidoptera:Tineidae) Monopis rusticella (Lepidoptera:Tineidae)
8th wave		3 years plus	Ptinus brunneus (Coleoptera:Ptinidae) Tenebrio obscurus (Coleoptera: Tenebrionidae)

Table 2.2 Species of faunal succession on human cadavers as tabulated by Megnin

Dr. Begeret d' Arbois is believed to be the first Westerner to use insects as forensic tools in 1855.[15] It began with a case of a body of a baby found behind the plaster mantle in a house in Paris, France. Evidence from flesh fly, *Sarcophaga canaria* showed that the state of decay was several years back and not linked to the current suspect.[16]

However, the history of forensic entomology can actually be traced back as far as the year of 1235 in China through a writing of a Chinese 'death investigator', Sung Tzu in a book called The Washing Away of Wrongs (Figure 2.1).[17] It is the first ever application of logical reasoning conducted to determine the guilt of a person. Following a murder by sickle, a number of farmers were assembled with their sickles laid before them upon the ground.

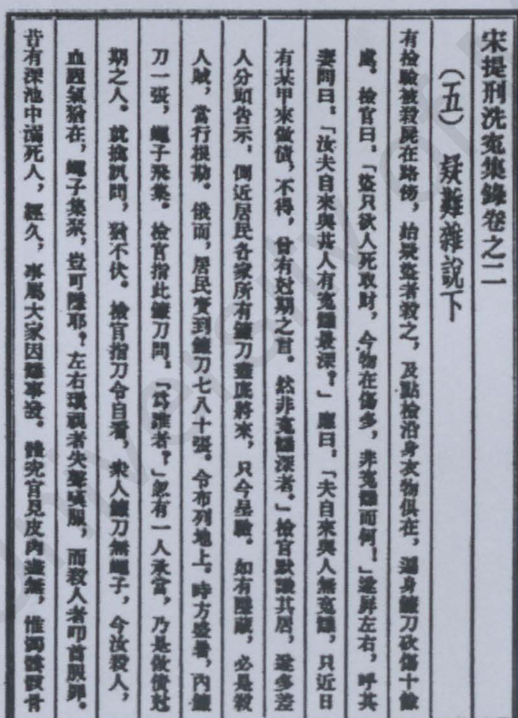
宋提刑洗冤集錄卷之二
（五）疑難雜說下
有檢驗被殺屍在路傍，始疑盜者殺之，及點檢沿身衣物俱在，遍身鐮刀斫傷十餘
處。檢官曰：「盜只欲人死取財，今物在傷多，非冤讎而何！」遂屏左右，呼其
妻問曰：「汝夫自來與甚人有冤讎最深？」應曰：「夫自來與人無冤讎，只近日
有某甲來做債，不得，曾有剋期之言。然非冤讎深者。」檢官默識其居，遂多差
人分頭告示：側近居民各家所有鐮刀盡底將來，只今呈驗。如有隱藏，必是殺
人賊，當行根勘。俄而，居民賫到鐮刀七八十張。令布列地上。時方盛暑，內鐮
刀一張，蠅子飛集。檢官指此鐮刀問：「為誰者？」忽有一人承當，乃是做債剋
期之人。就擒訊問，猶不伏。檢官指刀令自看：「眾人鐮刀無蠅子，今汝殺人，
血腥氣猶在，蠅子集聚，豈可隱耶？」左右環視者失聲嘆服，而殺人者叩首服罪。
昔有深池中溺死人，經久，事屬大家因讎事發。體究官見皮肉盡無，惟髑髏骨

Figure 2.1 Sung Tzu's book on forensic entomology application.

[15] http://www.research.missouri.edu/entomology/chapter1.html
[16] Lewis, R. 3 September 2004. Where the bugs are: forensic entomology. The Scientist, 10-13.
[17] Benecke, M. (2001). A brief history of forensic entomology. Forensic Science International.120, 2-14.

Flies settled on only one sickle (possibly because of the invisible remnants of tissue still adhering to it), the owner which then, confessed, admitted that he was the one who commit the murder. It was a classical story of how an initial understanding towards forensic entomology had been made. Today, researches are being conducted progressively to benefit information carried by insect, especially in the field of criminal investigation.

3. FORENSIC ENTOMOLOGY AS SCIENTIFIC EVIDENCE

As briefly informed earlier, the scientific properties of forensic entomology helps criminal investigator to estimate the time of death, determine location of a body and cause of death. This section will elaborate more on the role of forensic entomology information in order to assist crime investigation and the admissibility of such evidence in court.

3.1 The role of forensic entomology

a) Establishing the PMI

Time of death or the interval between time of death and time of body discovered is known as postmortem interval (PMI). Physical observation done only on bodies is not entirely complete but the combination of environment factor and body is crucial to determine PMI.[18] Therefore, the combination of scene and body examinations will give the investigator the best information to estimate when death is occurred.

In terms of forensic entomology, any stages of insect developments including eggs, larva, pupa and adults are essential to help establishing PMI. It is carried out by using these stages of insect development as time reference or in another terms, by determining insect's age, time of death can be estimated (Figure 3.1).

[18] See Dix, J. 2000. p. 1.

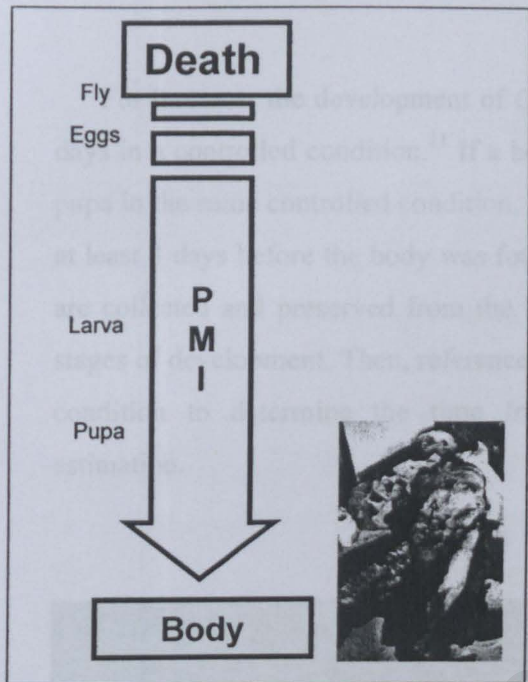

Figure 3.1 Link between time death and insect development with PMI.

Insects arrived on cadaver since the earliest time of death and forensic entomology is usually used to determine time of death in the later postmortem interval, when medical parameters are no longer of value.[19] Giant fly such as *Hypopygiopsis fumipennis* and *H. violacea* of Calliphorid family were found on 15 minutes after death.[20].

This is followed by *Chrysomya megacephala* and *C. rufifacies* which arrived on orifices of dead bodies to lay their eggs. The arrival of flies or insects on dead bodies creates a 'biological clock' which from every stages of

[19] Anderson, G.S. (2004). Determining time of death using blow flies eggs in the early postmortem interval. International Journal of Legal Medicine, 118, 240-241.
[20] Omar, B., Marwi, M.A., Sulaiman, S. & Oothuman, P. (1994). Observation on the behavior of immatures and adults of some Malaysia sarcosaprophagous flies. Tropical Biomedicine, 11, 149-153.

insect development, i.e. from eggs to adults, certain time frame can be obtained from different species of insect.

For instance, the development of *C. rufifacies* egg to pupa took at least 4 days in a controlled condition.[21] If a body found together with a *C. rufifacies* pupa in the same controlled condition, it can be concluded that death occurred at least 4 days before the body was found (Figure 3.2). Besides, larvae which are collected and preserved from the body will be identified its species and stages of development. Then, reference will be made towards the environment condition to determine the time frame of larval development in PMI estimation.

Figure 3.2 Fly pupae

In addition, insects' behavior are varies according to level of body decomposition. Not all of the insects actually feeding on cadaver and it can be simplified that four ecological categories can be recognized in the carrion community.[22] (Table 3.1)

[21] Goff, M.L. (2001). A fly for the prosecution. Fourth Edition. Cambridge: Harvard University Press.
[22] See Smith, K.G.V. (1986). page 13.

Species	Feeding behavior
Necrophagous	Feed on the cadaver itself and constitute the most important category in establishing time of death. Diptera:Calliphoridae (blowflies) Coleoptera (beetles): Silphidae, Dermestidae
Predators and parasites on the necrophagous	Second most important forensic category. Coleoptera: Silphidae, Staphylinidae Diptera:Calliphoridae (*Chrysomya*), Muscidae (Ophyra, Hydrotaea)
Omnivorous	Wasps, ants and some Coleoptera feed both on the corpse and its inhabitants.
Adventive	Use the corpse as an extension of their environment. Collembola (springtails), spiders (may become incidental predators)

Table 3.1 Insects' feeding behavior on cadaver

It should be noted that PMI establishment from methods described above is not the only a way of estimating the time of death. Until now, there is no specific method to accurately indicate time of death. However, forensic entomology is considered to be the most exclusive method to determine PMI and the estimation of such data can be used in court to prove the criminal was at the same place and time with the deceased.

b) Determining the location of death

The original location of a body can be determined by making a comparison between insects found on the body with the natural insects found in the environment.

For example, housefly, *Musca domestica* can only be found in house environment. If eggs and larva of this fly are collected from a body found in bushes or far away from living area, it shows that death occurred earlier in human living premises. The possibility that the body was removed from its original location is at high.

Such example is an idea on how forensic entomology can be used to determine the location of death. Furthermore, flies are also known to have different kind of oviposition behavior. For instance, *Calliphora sp.* prefers to lay eggs in a shady condition than a *Lucilia sp.* [23]

c) Finding the cause of death

Some insects can cause death in certain cases while some of them could help to find the cause of death. Wasp venom, for example, contains histamines, hiarulonidase enzymes and serotonin which could cause anaphylactic and

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[23] Stærkeby, M. (2000). Introduction to forensic entomology at http://www.uio.no/mostarke/forens_ent/forensic_entomology.html

hypersensitivity shock to the victim. In most cases, it could cause death to the victims.[24]

In the other hand, cause of death can be found through chemical composition found within the insects if such case involves poisoning. Poisons can be traced in nails, hair, urine and gastric contents but to analyze those from an active decomposing body is somewhat a difficult process.

Tracing of chemical compound can be carried out on insects' larva or pupa. Examples of chemical which are commonly traced are phenobarbitol, triazolam, cocaine and mercury.

Patterns of fauna or insects on the body can also exhibit clues to cause of death. In regular cases of suicide when the deceased used insecticide such as malathion, observation revealed that colonization of insects in mouth is slower than other part of orifices from the body. Sometimes, a major insect infestation in certain part of the body can determine the pattern of injury inflicted on the deceased (Figure 3.3). For example, stab wounds, gunshot wounds and head traumatic injury show major infestations of insects at injured area. In rape cases, insect colonization is obviously greater in genital region.

[24] Sulaiman, S. (1990). Entomologi perubatan. Bangi: Penerbit Universiti Kebangsaan Malaysia.

Figure 3.3 Heavy maggot infestation on arm suggests possible injury

The role of forensic entomology as scientific evidence as described above is crucial to assist forensic investigation and criminal justice process. It is important to rule out that insects evidence recovered from the crime scene must be admissible in criminal court.

3.2 Scientific Evidence in a Trial

Insects and other invertebrates feeding on carrion form a distinct faunal succession associated with the various stages of decay. Identification of the species involved in their different immature stages in the succession, combined with knowledge of their rates of development, can give an indication of the age of the corpse.[25]

Because of this, an entomologist may be called upon to identify specimens of insects for medico-legal purposes, particularly as an aid in establishing the time of death. It is the important factor to investigate murder cases which involve a badly decomposed body that is difficult for forensic pathologist to determine the time of death.

[25] See Smith (1986). p. 186.

The key question in this discussion is, to know how scientific evidence will be admissible in trial. Question, as to the requirement of expert witness to explain scientific evidence and the most effective method for presenting it to the judge will be discussed further below. Comparison between Malaysian legal systems will also be made with the American legal system.

3.2.1 Admissibility of scientific evidence

In the United States, the admissibility of scientific evidence including forensic entomology evidence is held under Federal Rule of Evidence 401, 402 and 403 of relevant evidence:

Federal Rule of Evidence 401

Definition of "Relevant Evidence."

"Relevant Evidence" evidence having any tendency to make the existence of any fact that is of consequence to the determinant of the action more probable than it would be without the evidence.

Federal Rule of Evidence 402

Relevant Evidence Generally Admissible; Irrelevant Evidence Inadmissible.

All relevant evidence is admissible, except as otherwise provided by the Constitution of the United States, by Act of Congress, by these rules, or by other rules prescribed by the Supreme Court pursuant to statutory authority. Evidence which is not relevant is not admissible.

Federal Rule of Evidence 403

Exclusion of Relevant Evidence on Grounds of Prejudice, Confusion or Waste of Time.

Although Relevant, evidence may be excluded if its probative value is substantially outweighed by the danger of unfair prejudice, confusion of the issues, or misleading the jury, or by considerations of undue delay, waste of time, or needless presentation of cumulative evidence.

To be compared with Malaysian legal system, scientific evidence is covered under Section 5, 6 and 7, regarding the relevancy of evidence:

Evidence Act 1957 (Act 56) Section 5

Evidence may be given of facts in issue and relevant facts.

Evidence may be given in any suit or proceeding of the existence or non-existence of every fact in issue and of such other facts as hereinafter declared to be relevant, and of no others.

Evidence Act 1957 (Act 56) Section 6

Relevancy of facts forming part of the same transaction.

Facts which, though not in issue, are so connected with a fact in issue as to form part of the same transaction are relevant, whether they occurred at the same time and place or at different times and places.

Evidence Act 1957 (Act 56) Section 7

Facts which are the occasion, cause or effect of facts in issue.

Facts which are the occasion, cause or effect, immediate or otherwise, of relevant facts or facts in issue, or which constitute the state of things under which they happened or which afforded an opportunity for their occurrence or transaction, are relevant.

In Malaysia, cases involving the evaluation of scientific evidence are still at the early level of argument and it is only to the extent of the competency of the expert witness in interpreting scientific evidence. Emphasize most given to the competency of the expert witness rather than the nature of scientific evidence and the specific techniques used in obtained scientific evidence.

Particularly in forensic entomology, such field is hardly recognized whilst it could give a corroborative value to established the time of death, other than pathological information and information obtained from the witness who the last saw the deceased alive.

Nonetheless, here are some examples which emphasized on the competency and credibility of expert witness, rather than looking into the scientific evidence which could be arguable.

In the case of *Junaidi Bin Abdullah v. Public Prosecutor,*[26] the admissibility of the evidence given by the government chemist was argued. It concerned the competency of the chemist as a witness to give evidence on the sevicibility of the revolver as an expert witness under Section 45 of the Evidence Act:

Evidence Act, 1950 (Act56) Section 45

Opinion of experts.

(1) When the court has to form an opinion upon a point of foreign law or of science or art, or as to identity or genuineness of handwriting or finger impressions, the opinions upon that point of persons specially

[26] [1993] 4 CLJ 209

skilled in that foreign law, science or art, or in questions as to identity or genuiness of handwriting or finger impressions, are relevant facts.

(2) Such persons are called experts

In this case, it was argued that only an armourer could give evidence on the servicibility of the firearms. Hj. Mohd. Azmi SCJ noted:

"It must be stressed at the outset that unlike the appeal before us, both authorities cited had reference to a charge of murder, but like it the expert witness was not an armourer but a chemist. Further the evidence sought to be adduced by the chemist in those cases was of a complex and scientific nature which was whether or not a particular bullet which had killed the deceased had been fired through the barrel of a particular firearm which belonged to the accused. In both cases, the chemist was held to be a competent witness to express a forensic opinion in the matter..."[27]

The court referred to *Public Prosecutor v. Muhamed bin Sulaiman*:[28]

"The only question was, is Mr. Lum *perltus*, is he skilled, is he skilled in determining whether a particular bullet has gone through the barrel of a particular rifle. He need not become so skilled in any particular way nor by special study nor professionally. It is enough if he has had sufficient experience, sufficient practical experience, to acquire the necessary skill, so that he has adequate knowledge."

Based on the cases above, and other cases including *Munusamy v. Public Prosecutor*[29] and *Dato' Mokhtar bin Hashim v. Public*

[27] *Ibid.*. p. 209.
[28] [1982] 2 MLJ 323.

Prosecutor,[30] less emphasize were given to the nature of scientific evidence, except in the case of *Khoo Hi Chiang v. Public Prosecutor*,[31] it was noted:

"It is appropriate at the outset to determine whether the evidence of a chemist on the identity of a drug constitutes evidence of fact or opinion and to consider the attendant issue governing the admissibility of such evidence. **If the chemist's evidence is factual, then it follows that he is competent to give evidence like any other witness and by the same token the law on the admissibility of such evidence would apply. If the chemist's evidence constitutes an opinion, then his evidence would come under the category of expertise evidence. In that case the question of his competency to give expert evidence arises.** The law seems clear that opinions of experts are under certain conditions admissible in evidence."[32]

The case also referred to *Torenia*:[33]

"The question therefore becomes a question whether or not the evidence which it is sought to adduce is to be categorized as expert evidence. In a case of this kind one can analyze the matter in this way: First, evidence is adduced which can be described as direct factual evidence, which bears directly on the facts of the case. Second, there is opinion evidence which is given with regard to those facts as they have been proved, and then, thirdly, there is evidence which might be described as factual, which is used to support or contradict the opinion evidence. This is evidence which is commonly given by experts, because in giving

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[29] [1987] 1 MLJ 492
[30] [1983] 2 MLJ 270
[31] [1994] 2 CLJ 151
[32] *Ibid.* p. 151
[33] 2 Lloyd's Rep. 210

their expert evidence they rely upon their expertise and their experience, and they do refer to that experience in their evidence. So an expert may say what he has observed in other cases and what they have taught him for the evaluation of' the facts of the particular case. So also experts giving evidence about experiments which they have carried out in the past or which they have carried out for the purpose of their evidence in the particular case in question."[34]

The distinctive explanation given in *Khoo Hi Chiang's* case provides a specific view on the function of factual evidence i.e. the scientific evidence, and the role played by expert witnesses to establish the scientific explanation of such evidence.

In the American legal system, there are two ways which scientific evidence may be inaccurate. First, the underlying theory and principles may be erroneous and second, the scientific theory may be valid but the person or persons applying it may have committed error in techniques.[35] These four tests may approve scientific evidence in trial:[36]

a. Any sample tested must be shown to have been uncontaminated, with appropriate proof of chain of custody to establish that the sample was in fact the actual sample taken from the scene of the incident in question.
b. Scientific theory and technique must be shown to be valid i.e., it measures what it purports to measure.
c. The theory and technique were properly applied in the case at hand.
d. The test results were properly analyzed and interpreted.

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[34] 2 Lloyd's Rep. 215

[35] Greenberg, B. & Kunich, J.C. (2003). *Entomology and the Law,* 222.

[36] *Ibid.*. p. 222.

In *Daubert's*[37] case, two minor children born with serious birth defects. The children and their parents brought suits alleging the birth defects were caused by the mother's ingestion of Bendectin, an anti-nausea drug, during pregnancy. With the experts at trial, the court concluded that plaintiffs had provided an insufficient in proving causation.

The court noted:

"Ordinarily, a key question to be answered in determining whether a theory or technique is scientific knowledge that will assist the trier of fact will be whether it can be (and has been) tested…Another pertinent consideration is whether the theory or technique has been subjected to peer review and publication…Submission to the scrutiny of the scientific community is a component of "good science," in part because it increases the likelihood that substantive flaws in methodology will be detected. The fact of publication (or lack thereof) in a peer-reviewed journal will thus be relevant, though not dispositive, consideration in assessing the scientific validity of a particular technique or methodology…Additionally, in the case of a particular scientific technique, the court ordinarily should consider the known or potential rate of error…and the existence and maintenance of standards controlling the technique's operation. Finally, "general acceptance" can yet have a bearing on the inquiry…Widespread acceptance can be an important factor in ruling particular evidence admissible, and a known technique that has been able to attract only minimal support within the community may properly be viewed with skepticism." [38]

[37] 509 U.S. 582-583.
[38] *Ibid.* p. 593-594.

Daubert's case gives an important distinction between scientific evidence and specialty of an expert witness. In *United States v. Bynum*,[39] similar emphasized was also given to the importance of scientific evidence. The Court stated:

"Scientific knowledge is generated through the scientific method – subjecting testable hypotheses to the crucible of experiment in an effort to disprove them. An opinion that defies testing, however defensible or deeply held is not scientific." [40]

It is therefore can be concluded that scientific evidence could be the strongest evidence can be used in trial and the effort is needed through the support of an expert witness.

3.2.2 Other nature of scientific evidence

Beside forensic entomology, there is other scientific evidence which is naturally admissible in court but under certain circumstances, the evaluation is far more complex. Stated below are discussions on scientific evidence evaluation in court involving DNA and polygraph tests.

a) Deoxyribonucleic acid (DNA)

DNA is the genetic material that defines sequence of heredity and contained in nucleus of living cells in the body. DNA is the basic component that create chromosomes and unique to every individual except in identical twins or monozygote twins.

[39] *United States v. Bynum*, 3 F.3d 769 (4th Cir. 1993)
[40] *Ibid.* p. 773.

DNA evidence is generally relevant and admissible in court. In *Lau Zhan Chen (an infant by his mother and next friend Lau Fatt Wan (f)) v. Makoto Togase & 2 Ors,*[41] describes a case involving a paternity petition. DNA test was conducted by using the first respondent's blood sample as a declaration was sought by the petitioner that he was the legitimate child of the first and second respondents. It was later proven by the DNA test that the first respondent was the biological father of the petitioner. His Lordship Abdul Malik Ishak J granted the declaration sought by the petitioner:

"In my judgment, where scientific evidence by means of a blood test, can resolve the issue of paternity conclusively, the interest of justice require that a blood test should be done, in the absence of strong reasons to the contrary…"

From the example of the case above, DNA evidence has been accepted as a tool for identification and individualization. This specific genetic material of a person is reproduced unvaryingly in the various cells and can be compared with other similar material by the known methods of DNA extraction.[42]

However, there are natural circumstances where such DNA evidence is excluded in trial. These circumstances generally involve errors in methodology or mistakes in the application of DNA technique.[43]

Therefore, an expert's opinion is essential and will be needed to deal with any issue of whether a particular laboratory method is

[41] [1995] 1 AMR 281

[42] Xavier, G.A. (1998). Scientific Evidence - DNA. *Journal of crime,* 3, 11.

[43] Callahan, J. (1996). Survey: The admissibility of DNA Evidence in the United States and England. *Suffolk Transnational Law Review,* 19, 537.

sufficiently accepted to allow the admission of the evidence without being argued.[44]

i. Standard Techniques in DNA Profiling

DNA extracted from biological sample such as blood, bloodstain or semen is profiled through scientific techniques of profiling i.e. single locus probe test and short tandem repeats typing based on polymerase chain reaction technology:[45]

(a) Single locus probe (SLP) test.

DNA obtained from a sample is cut into small lengths by specific restriction enzymes. These fragments are placed in a gel and arranged by size through process of electrophoresis, which draws the fragments by electromagnetic force along a track in the gel. The fragments with a smaller molecular weight travel further than the heavier ones.

A pattern of bands which is produced is then transferred from the gel to a membrane. A DNA probe which is radioactive is then added and excess DNA washed off. The bands that are revealed are then recorded as X-ray film.

The important feature of this test is the comparison of the positions of bands produced from a crime sample and the suspect, to see if they match. In addition to doing a visual comparison to see if the bands appear to match in position, a comparison and estimation of the size of the DNA fragment producing the band in

[44] See Xavier (1998). p.11.
[45] *Ibid.* p. 12.

each position is also done to determine whether or not they match. The size of each DNA fragment can be estimated by comparing its position with fragments of a standard size, which is routinely included in each test.

It is obvious, before any decision is reached as to whether two bands match for a visual examination as well as a comparison of the estimated fragment sizes to be made. The photographic film is therefore examined to see if the position of the DNA fragments from the crime sample and the suspect correspond.

A complication which may arise when using the SLP test is when the fragments of DNA of the same size, even when they are from the same individual, can move to slightly different positions when they are sorted, by subjecting them to electric current. This may occur when the fragments are tested on different occasions, or even in the same test. Thus when the bands are being compared, it must be realized that they may not align precisely and therefore allowance has to be made for this.

(b) Short tandem repeats (STR) typing based on polymerase chain reaction (PCR) technology.

PCR is a technique which can be used to multiply million fold, specific portions of DNA which are present in a sample, by copying small sections of DNA in a test tube. Therefore only the STR fragment which the scientist is interested in is amplified so that the fragment is separated from the remaining DNA. Useful results can as such be obtained from material which previously would have been insufficient of which had been subjected to unfavorable conditions and had degraded.

These fragments are then sorted according to their size by moving them through a gel under the influence of an electric current, as in done in SLP tests. In the UK, a computer is used to record the length of time taken by the fragments to reach a predetermined finishing line in the gel. The point at which the fragment passes the finishing line is shown on the computer printout as a peak. The computer is set that only peaks above a minimum level are printed out. Only peaks above this level would normally be considered as providing reliable evidence of the presence of a fragment.

In addition a comparison is done by the sample run at the same time as each test sample. This enables an estimate of the sizes of the fragments in the test sample to be produced because the speed with which fragments move through the gel is related to their size.

From the fragment sizes which are given in base pairs on the printout, it would then be possible to assign the STR type in terms of the number of repeated sections that compose the fragments detected in the sample under investigation. However, there may be variations in the estimated sizes of the fragments, when the fragments are tested in difference occasions or when investigating the same type of fragment occurring in different individuals. The scientist would then have to determine the STR category or type into which this must be considered to fall.

ii. The Problematic Issues of DNA evidence

In DNA identification, the scientist compares profiles from samples to determine whether or not they are similar to those obtained from known samples from a suspect or victim. The inclusion of the evidence can be made if the samples are found match. In another terms, the DNA profiles from the two samples are sufficiently similar and could not have originated from the same source.[46]

However the exclusion of the DNA evidence may occur if the DNA profiles are dissimilar and could not have originated from the same source, and such evidence may also be inconclusive when the data are insufficient to exhibit an interpretation. These problems may be due to several factors which could affect the reliability of DNA evidence.

The conditions of the samples collected from the crime scene are usually far from ideal.[47] Often, such samples may have been severely degraded due to their age or contaminated by bacterial, viral or non-human DNA prior reaching to the laboratory. Sometimes, DNA samples obtained from the scene is too small and inadequate to run DNA tests. Hence, procedures of DNA samples collection must be carefully manhandled.

In laboratory, it is possible that the DNA thread had not been completely cut into separate fragments by the specific restriction enzymes.[48] This may occur when there is too little of the

[46] Bruce Budowle, Keith L. Monson and James R. Woodley. (1992). Reliability of statistical estimates in forensic DNA typing. In Paul R. Billings (Ed.). DNA on Trial.Cold Spring Harbor Laboratory Press. page 79.
[47] See Xavier, page 15.
[48] *Ibid.* p. 15.

restriction enzymes in relation to the volume of DNA to be cut. As a result, fragments which should have been separated will therefore remain joined and thus will appear in a different position on the X-ray. In this occasional problem, the sensitivity of DNA test must be focused to minimize its error in producing reliable scientific evidence.

b) Polygraph Test

Polygraph test had also been a subject of argument in the nature of scientific evidence in the United States as described in *Frye v. United States.*[49]

Briefly in *Frye*'s case, the defendant had been given during pre-trial, a systolic blood pressure test which was an early form of polygraph or "lie detector" test. It measured his blood pressure as he was asked a series of questions. Defendant Frye had a witness who was prepare to testify that changes in Frye's blood pressure during questioning indicating that he was being truthful in his responses when he denied committing the crime of second-degree murder. The witness was ready to testify in support of the scientific theory and also his instrumentation. Although such evidence would have satisfied the authentication requirement applicable to evidence in general, the trial court judge refused to allow it to go before the jury after hearing the witness testifies in a session outside the presence of the jurors.

The Judge concluded:

"Just when a scientific principle or discovery crosses the line between the experimental and demonstrable stages is difficult to

[49] 293 F. 1013 (1923)

define. Somewhere in this twilight zone the evidential force of the principle must be recognized, and while the courts will go in a long way in admitting expert testimony deduced from a well-recognized scientific principle or discovery; **the thing from which the deduction is made must be sufficiently established to have gained general acceptance in the particular field in which it belongs. We think the systolic blood pressure deception test has not yet gained such standing and scientific recognition among physiological and psychological authorities as would justify the courts in admitting expert testimony deduced from the discovery, development, and experiment thus far made.**"[50]

The judgment above was argued and criticized because the Court failed to cite any authority that could support the test announced and did not set any rationalization the scientific evidence. The question is what percentage of experts from a related field of study must accept a scientific technique or principle before it can be considered as 'generally accepted'?

In *People v. Kelly,*[51] the California Supreme Court hypothesized:

"The Frye test…may well promote a degree of uniformity of decision. Individual judges whose particular conclusions may differ regarding the reliability of particular scientific community…The primary disadvantage, however, of the Frye test lies in its essentially conservative nature. For a variety of reasons, Frye was deliberately intended to interpose a substantial obstacle to the unrestrained admission of evidence based upon new scientific principles."

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[50] *Frye v. United States,* 293 F. 1014 (1923)

[51] 549 p.2d 1240 (1976)

Based on the above opinion, in referring to *Frye*'s case, conclusions by a judge regarding the acceptance of scientific evidence rely on the particular community that understands scientific evidence. In *United States v. Scheffer,*[52] the Court noted:

"By its very nature, poly graph evidence may diminish the jury's role in making credibility determinations...Unlike other expert witnesses who testify about factual matters outside the jurors' knowledge, such as the analysis of fingerprints, ballistics, or DNA found at a crime scene, a polygraph expert can supply the jury only with another opinion, in addition to its own, about whether the witness was telling the truth. Jurisdictions, in promulgating rules of evidence, may legitimately be concerned about the risk that juries will give excessive weight to the opinions of a polygrapher, clothed as they are in scientific expertise at times offering, as in respondent's case, a conclusion about the ultimate issue in the trial. Such jurisdictions may legitimately determine that the aura of infallibility attending polygraph evidence can lead to jurors to abandon their duty to assess credibility and guilt. Those jurisdictions may also take into account the fact that a judge cannot determine, when ruling on a motion to admit polygraph evidence, whether a particular polygraph expert is likely to influence the jury unduly. For these reasons, the President is within his constitutional prerogative to promulgate a per se rule that simply excludes all such evidence."[53]

Finally, the Court concluded that the definite exclusion of polygraph evidence turns the problem of judicial process to resolution of collateral matters:

[52] 523 U.S. 303 (1998)
[53] *Ibid.* p. 313-315.

"Such collateral litigation prolongs criminal trials and threatens to distract the jury from its central function of determining guilt or innocence. Allowing proffers of polygraph evidence would inevitably entail assessments of such issues as whether the test and control questions were appropriate, whether a particular polygraph examiner was qualified and had properly interpreted the physiological responses, and whether other factors such as countermeasures employed by the examinee had distorted the exam results. Such assessments would be required in each and every case. It thus offends no constitutional principle for the President to conclude that a per se rule excluding all polygraph evidence is appropriate. Because litigation over the admissibility of polygraph evidence is by its very nature collateral, a per se rule prohibiting its admission is not an arbitrary or disproportionate means of avoiding it."[54]

Polygraph test in *Frye*'s case and DNA, as discussed at quite a great length, are examples of the basis of scientific evidence evaluation in legal definition.

The ultimate objective of the *Frye* test is to ensure that only scientific evidence that is reliable will be admitted. It does so by requiring that the underlying theory and technique have been sufficiently used and tested within the scientific community to have gained general acceptance.[55]

In Malaysia, the question whether polygraph evidence is conclusive or otherwise depends on the fundamentals of scientific evidence. Selecting the appropriate field may create difficulties

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[54] *Ibid.*.p. 315.

[55] Lorne T. Kirby. (1992). DNA Fingerprinting: an introduction. Oxford University Press, 193.

because multiple disciplines may be involved in application of the scientific evidence. Selection of a broad field may include scientists who have no experience in the forensic application of the theory and technique, whereas a narrow field might limit the prospects to those who are proponents to a new theory and technique and who apply them commercially in forensic settings.

Furthermore, Malaysian courts must differ on whether only the underlying scientific principle must be accepted by the scientific community or whether in addition to the technique applying that principle must also be generally accepted. Once the court has determined the scientific fields from which the experts are to be drawn and what must be generally accepted, it must then decide what general acceptance means in order to admit polygraph test as conclusive evidence.

4. FORENSIC ENTOMOLOGY PROCEDURE

Criminal investigation using forensic entomology as an investigation tool consists of a series of procedural process. In this part of discussion, interviews had been conducted with experts who are directly involved in forensic entomology application.[56]

In general, the process of accepting forensic entomology as can be observe from the time insect specimen collected at the crime scene to the time it is presented in court as scientific evidence.

While pioneering countries such as United States and United Kingdom welcomes the participation of forensic entomologist at the crime scene, in Malaysia, the practice of insect collection is currently exclusively carried out by Polis Diraja Malaysia (PDRM) Forensic Unit.

Analysis and identification of insects are subsequently carried out mainly in Malaysian Medical Research Institute (IMR) located in Jalan Pahang, Kuala Lumpur as well as academic and research institutions such as Universiti Kebangsaan Malaysia (UKM).

Results obtained from the analysis will be delivered to the police for further investigation and filed as prosecution evidence (Figure 4.1).

[56] Unofficial interviews was conducted during the period of this research project. The two experts are DSP Amidon Anan, Head of Forensic Unit at IPK Selangor and Dr. Lee Han Lim, Head of Medical Entomology Department, IMR.

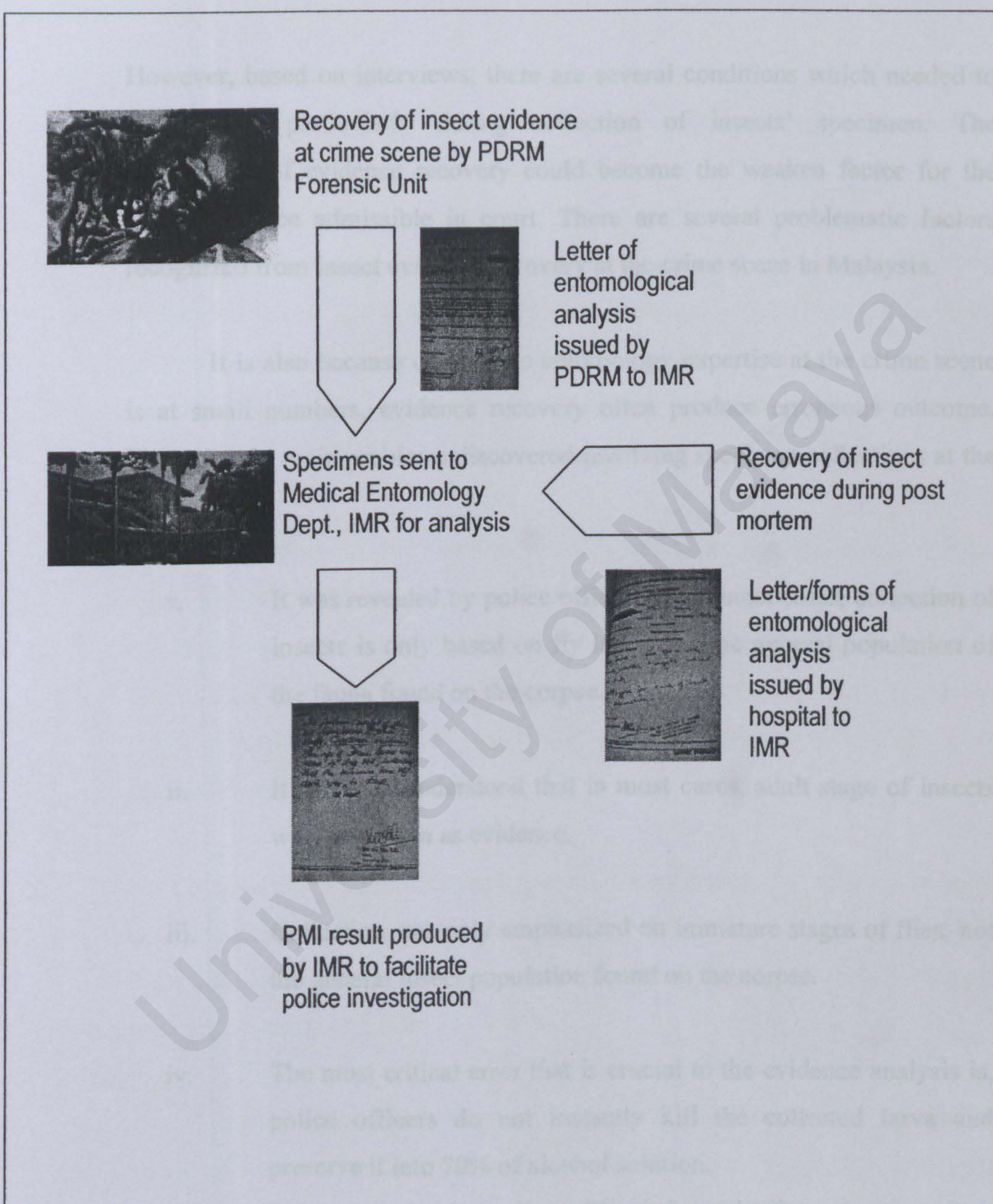

Figure 4.1 Process of forensic entomology evidence analysis

4.1 Problems Facing Forensic Entomology Evidence Recovery

However, based on interviews, there are several conditions which needed to be revised, particularly during collection of insects' specimen. The malpractice of evidence recovery could become the weaken factor for the evidence to be admissible in court. There are several problematic factors recognized from insect evidence recovery at the crime scene in Malaysia.

It is also because of forensic entomology expertise at the crime scene is at small numbers, evidence recovery often produce erroneous outcome. These are the main problems discovered involving specimen collections at the crime scene:

i. It was revealed by police officer that in most cases, collection of insects is only based on fly larva, not the general population of the fauna found on the corpse.

ii. It was also understood that in most cases, adult stage of insects were not taken as evidence.

iii. Collection was only emphasized on immature stages of flies, not the general insect population found on the corpse.

iv. The most critical error that is crucial to the evidence analysis is, police officers do not instantly kill the collected larva and preserve it into 70% of alcohol solution.
It is a practice by police officers from the forensics to collect larva in a bottle and let them naturally die.

Such action could affect the lifespan of the insects and deteriorate PMI estimation.

All of the problems above could give a major impact to admissibility of such evidence in court when the reliability to provide information and clues to the time and cause of death can be questioned.

In a case recorded by a Malaysian forensic entomologist, Prof. Dr. Baharudin Omar, the absence of forensic entomologist at crime scene could give a misleading evaluation of PMI. Based on his experience conducting a couple of dead Indian bodies found hanged believed to be caused by suicide, he was given a fly larva to identify.[57]

According to the specimen, he concluded that the corpses aged approximately 3 days. But his opinion was objected by pathologist because the bodies were found badly decomposed and the time of death might be longer than Prof. Baharudin estimated. For further analysis, he visited the crime scene where the body was found and discovered a colony of newly hatched flies, *Ophyra sphynigera*.

Based on previous research, such species would only arrive on cadaver approximately 25 days after death. This time, his estimation was right when the police discovered that there was a report of a missing Indian couples within that period of time.

Such scenario above displays the importance of forensic entomologist to be at the crime scene and not to necessarily analyze insects found on cadaver. Evidence collected from environment is crucial to help determine PMI and other role of forensic entomology.

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[57] Nik Khartina Nik Man. April 2005. Ciri lalat bongkar misteri mayat. Dewan Kosmik, 12-13.

Such problem is also occurring in the United States as quoted from Missouri's website:

"...medicocriminal entomologists are seldom included on routine crime scene investigation teams. Whether this has occurred because such specialists are rare, because their presence is inconvenient or impractical, or because their area of expertise is not appreciated fully for either its uniqueness or potential contribution to forensic pathology is immaterial. A major result has been that an important responsibility of medicocriminal entomologists consists of training crime scene technicians and allied personnel to recognize, obtain, and properly preserve entomological evidence. The entomologist then reviews such evidence and often provides expert assistance if entomological data appear crucial to the case. Important to the latter function are eventual qualification as an expert witness, the increased professional status of entomologists toward that end, a facility with courtroom protocol, and a fee structure related to this effort.

Most up-to-date investigative units acknowledge in their standard operating procedures (SOP's) the potential for acquisition of entomological evidence. The purpose of the Procedural Guide is to facilitate that objective." [58]

Furthermore, there is always a risk of contamination while handling entomological specimens at crime scene. Fly pupae may contaminate forensic entomology samples at crime scenes if they have originated not from human remains but from animal carcasses or other decomposing organic material.[59]

[58] http://www.research.missouri.edu/entomology/chapter1.html

[59] Archer, M.S., Elgar, M.A.,Briggs, C.A. & Ranson, D.L. (2005). Fly pupae and puparia as potential contaminants of forensic entomology samples from sites of body discovery. International Journal of Legal Medicine (Case report)

These contaminants may erroneously lengthen post-mortem interval estimates if no pupae or puparia are naturally associated with the body.

To outcome such problems, it is therefore, would be wise to set up tools to assist every parties in forensic entomology evidence recovery through Standard Operating Procedure from crime scene to insect identification procedures in laboratory.

4.2 Standard procedure for entomological evidence recovery

a) Analyzing the crime scene for entomological evidence visually.

i. The type of habitat the crime scene is located in.

ii. Estimate the number and kinds of crawling and flying insects.

iii. Note locations of major infestations associated with the body and surrounding area.
These infestations may be egg, larval, pupa or adult stages, alone or in any combinations of the above.

iv. Note immature stages of particular adult insects observed. These stages can include eggs, larvae, pupae, empty pupa cases, cast larval skins, fecal material and exit holes or feeding marks on the remains.

v. Note any insect predation such as beetles, ants and wasps or insects parasites.

vi. Note the exact position of the body: compass direction of the main axis, position of the extremities, position of the head and face, noting of which body parts are in contact with substrate, noting where it would be sunlight and shade during a normal daylight cycle.

vii. Note insect activity within 3-6 m of the body. Observe flying, resting or crawling insect adults or larvae or pupae within this proximity to the body.

viii. Note any unusual naturally occurring, man-made or scavenger-caused phenomenon which could alter the environmental effects on the body (trauma or mutilation of the body, burning, covering, burial, movement or dismemberment).

ix. Photographs should be taken on the different stages of insect found before collecting specimens.

b) <u>Collection of climatological data at the scene.</u>

Climatological data or weather information at the crime scene is critical because the length of the insect cycle determined mostly by temperature and relative humidity in the environment.

Weather data for the scene should be collected from the nearest meteorological station. The climatological data should extent back to the time the victim was last seen.

i. Ambient temperature can be evaluated by taking readings at 0.3 to 1.3 m heights in close proximity to the body.

ii. Ground temperature can be obtained by placing the thermometer on the ground, immediately above any surface with ground cover.

iii. Body surface temperature can be obtained by placing the thermometer on the skin surface.

iv. Under-body interface temperature can be obtained by sliding the thermometer between the body and the ground surface.

v. Maggot mass temperatures can be obtained by inserting the thermometer into the center of the maggot mass.

vi. Soil temperatures should be taken immediately after body removal at a ground point which was under the body before removal. Also take soil temperatures at a second point 1-2 m away from the body. These temperatures should be taken at three levels: Directly under any ground cover (grass, leaves, etc.), at 4cm soil depth and at 20 cm soil depth.

c) Collection of specimens from the body before body removal.

i. Use insect net to collect flying insects.

ii. Eggs, larvae, pupae and adults of insects on the surface of the human remains should be collected and preserved to show the state of the entomological data at the time of discovery.
Larvae must be preserved instantly in 70% alcohol.

iii. Samples of egg, larvae and pupae should also be collected alive and placed on a rearing medium such as raw beef liver. Rearing to adult stage makes identification easier and may give vital clues to the PMI estimation. The temperature in the rearing container must be as constant as possible in the range of 20-27°Celsius.

iv. Every collection must be labeled of its location of origin i.e. the body parts or environment.

d) Laboratory procedure

Laboratory procedure involving entomological evidence collected at crime scene is carried out by standard procedure according to Lee's procedure.[60]

The following methods are being used to process larva specimen:

i. Clear the larvae by soaking in 10% Potassium Hydroxide (KOH) in a covered glass block for 4-24 hours depending on the types of specimen.

[60] Lee, H.L. (1989). Recovery of forensically important entomological specimens from human cadaver in Malaysia - an update. Malaysian Journal of Pathology. 11, 33-36.

ii. Rinse larvae thoroughly with distilled water and transfer carefully to 10% acetic acid for 30 minutes to neutralize the alkaline solution.

iii. Soak the larvae in a small dish of distilled water and during this time, cut a small incision transversely at the last segment of fly larvae to remove all larval internal organs in order to facilitate taxonomic studies.

iv. Cut off completely the last segment of the larvae which contains posterior spiracles, the important taxonomic features.

v. Dehydrate the larvae and detached segment by soaking in ascending series of ethanol for 30 minutes in each concentration.

vi. Clear the specimen in clove oil for 30 minutes.

vii. Rinse briefly with xylene and then mount the specimen on a glass slide by using Canada Balsam.

viii. Dry the slides in an oven at 30°Celsius for 24 hours.

Identification of larvae and adults can be carried out by using taxonomic keys such as the ones prepared by Ishijima[61] or Tumrasvin *et al.*[62]

To permit quick identification of arthropods, random amplified polymorphic DNA typing (RAPD) can be used to support classical morphological and medico-legal analysis of maggots on a human corpse but such method is not commonly and practically used due to costly apparatus.[63]

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5. CONCLUSION

The science of forensic entomology is the application of insect biology to the investigation of crime. However, the improper or negligent of professional practice at crime scene could implicate evidence admissibility.

Several problems have been identified and the nature of such cause is due to lack of forensic entomology expertise at the crime scene. The presence of such experts will not only as a practical worker to collect insect specimens but accurate observation is important to be made by individuals who are experts in insects' biology.

IMR is currently developing Forensic Entomology Kit as a tool to assist forensic investigator at crime scene because as far as everyone is concerns, evidence recovery is a vital process. Standard guidelines are being set up to deliver the right working methods for forensic investigators. Nevertheless, at the same time, tedious work must be conducted continuously to enrich the database of insect taxonomy and its application in establishing PMI.

It is therefore important to establish a standard guideline for all forensic investigators at the crime scene in order to strengthen up the value of evidence recovery.

5.1 Recommendations

1. Forensic entomologists must be called to the crime scene to assist investigation and recover entomological evidence.
2. Regulate standard procedures for handling entomological evidence.
3. Continuous research for entomological database to assist PMI estimation.

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